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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Jawad Haidar	) Group Art Unit: 7414
SERIAL NO:	10/560,804	) Examiner: Zhu, Weiping
FILED:	December 15, 2005	) Docket: CU-4560
TITLE:	A METHOD AND APPARATUS FOR THE PRODUCTION OF METAL COMPOUNDS	

THE COMMISSIONER FOR PATENTS
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AFFIDAVIT UNDER 37 CFR 1.132

I, Anthony B Murphy, the first author of the paper 'Equilibrium calculations of the reduction of titanium tetrachloride by aluminium and hydrogen', published in *High Temperature Chemical Processes*, volume 3, pp. 365-374 (1994), declare as follows:

1) This paper presents the results of theoretical calculations of the composition of mixtures of argon, hydrogen, aluminium and titanium tetrachloride, performed under the assumption of chemical equilibrium. The calculations indicate that, for some mixtures of the above substances, solid titanium and solid titanium aluminides can be formed at temperatures below about 3000 K.

2) In interpreting the results of these calculations, it is vital to take into account the assumption of chemical equilibrium that underlies the calculations. Chemical equilibrium calculations are based on the assumption that all chemical reactions run to completion. For this assumption to be valid, the following must all be true:

1. The reactants for each reaction must have sufficient energy to overcome the energy barrier for that reaction;
2. There must be sufficient time allowed for each reaction to run to completion;
3. The reactants must be able to make good contact with each other, so that the reactants should all be in the gas or possibly liquid phase. Alternatively, one reactant could be in solid form, but should have a very large surface area to volume ratio (e.g., be in nanopowder form) to allow good contact with the other reactants.

3) Each of these three requirements is favoured by high temperatures. At high temperatures, requirement 1 is more likely to be satisfied because the reactants have greater energy, requirement 2 is more likely to be satisfied because reaction

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rates are higher, and requirement 3 is more likely to be satisfied because the reactants are more likely to be in the gas phase.

4) The paper was written to assess the viability of conversion of titanium tetrachloride to titanium using aluminium or hydrogen or both aluminium and hydrogen combined as reducing agents. As is made clear in Section 4 of the paper, the scheme that was being assessed involved heating of all reactants to a temperature at which only gaseous species were present, about 3000 K or higher. The gas mixture would then be cooled sufficiently slowly to allow chemical reactions to run to completion. As the mixture cooled, liquid and solid substances would be formed. The calculations presented in the paper predicted that some conditions these substances would be titanium and titanium aluminides.

5) The methods used in the paper are not suited to the calculation of reactions involving solid reactants, because the reactants do not make good contact with each other, and diffusion of chemical species through solids is very slow. Further, at the lower temperatures at which condensed species are present, the reactants are less likely to have sufficient energy to overcome energy barriers, and the rates of reactions are slower. Hence the chemical equilibrium assumption is not appropriate, and the calculations are not applicable.

I further declare that all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: May 1, 2009

Anthony B Murphy